THE SIGNIFICANCE OF THE ANS PROJECT FOR DUTCH INDUSTRY

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16. Abstract The ANS (Dutch astronomical satellite) project is the first substantial research and development project to be undertaken by the Dutch aerospace and electronics industry with government support. The present work attempts to point out the advantages, both economic and technological, which will ensue from this project and the subsequent undertaking of similar projects in the future. A strong argument is the general beneficial effects that government-supported projects in large countries, the U.S., for example, have had.

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THE SIGNIFICANCE OF THE ANS PROJECT FOR DUTCH INDUSTRY

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The ANS (Dutch astronomical satellite) project is being carried out with close collaboration among astronomers, industry and the government, which all maintain relations with the other organizations that are working towards the realization of the project. Since this is the first significant Dutch satellite project, the industry is developing its contributions in research and development laboratories. The work to be performed is related to or is an essential part of other research and development activities of the aerospace and electronics industry. Today's presentations may well show how closely research and development activities for space flight are linked with the more terrestrial technologies. /59*

There have been many attempts to demonstrate explicitly the significance of research and development for space flight. Since this work does not usually differ significantly from the work usually undertaken for technological advance in these branches of industry, methods which attempt to trace the influence on well-defined, real products or techniques will rarely lead to results which are of consequence for aerospace research. In order to assess the value of research and development for space flight, here we shall pay attention to the meaning of research and development for society in general; macroscopic observations will be employed for this purpose. Next, the significance of research and development for industry and society will be closely investigated. On the basis of the above considerations, it is possible to evaluate the significance of the ANS project for Dutch industry.

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* Numbers in the margin indicate pagination in the foreign text.

Extent of Research and Development

The extent of the scope of work for technological advance in the aerospace and electronics industry may be estimated by using data of the National Science Foundation. In 1971, the U.S. spent 27.3 billion dollars for research and development. Of this amount, 7 billion dollars were used for electronic apparatus and telecommunications, and 5.8 billion dollars for the construction of airplanes and rockets. In other words, the American aerospace and electronics industry spent 12.8 billion dollars for research and development in 1971. We may deduce from this figure that the price of progress in the aerospace and electronics industry in the entire western world is 25 billion dollars per year. If we assume that there are 25 innovations per year in this industry, that are conspicuous and worth mentioning, the average cost of each would be 1 billion dollars.

Although the above expenses are considerable, it seems that /62
the results justify the efforts.

The Midwest Research Institute, under contract to NASA, has inquired into the profitability of research and development. The Institute calculated how the gross national product would have developed if there had not been any research and development after 1949, and they compared these findings with the actual situation. The difference is the result of technological progress. The results of these investigations are shown in Fig.1. For the sake of completeness, a survey of the expenditures for research and development in the United States for the period 1953-1973 is also included (Fig. 2). Based on these observations, the Midwest Research Institute concluded that every dollar spent on research and development over a period of 18 years yields, on the average, 7 dollars for the American economy as a result of technological advance.

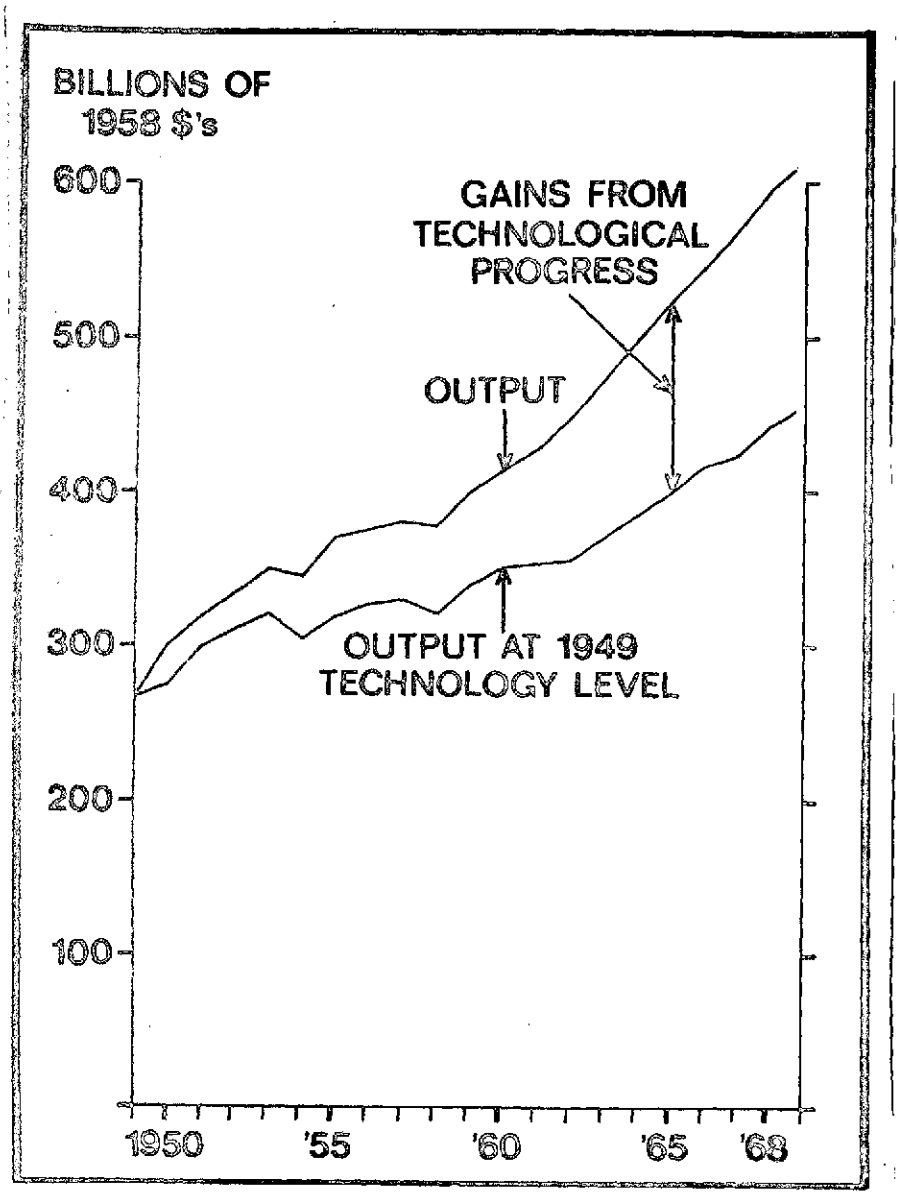

Fig. 1. Effect of technological progress on the gross national product in the USA. The upper curve indicates the real gross national product, and the lower curve shows how the gross national product would have developed if there had not been any technological advance after 1949. The difference is the result of technological advance. The values are corrected for inflation by using 1958 dollar values. The calculations were made for NASA by the Midwest Research Institute (Contract MASw-2030).

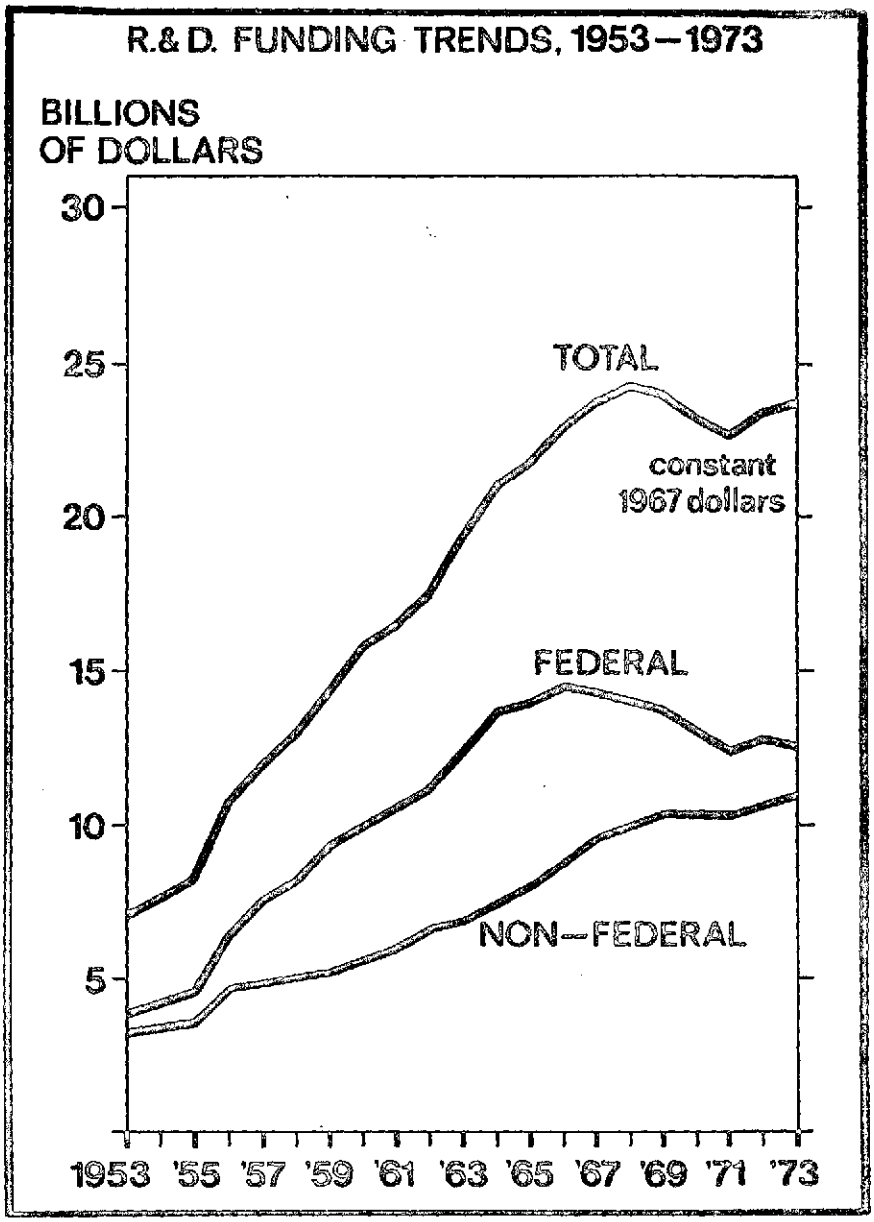

Fig. 2. Expenditures for research and development in the United States for the period 1953-1973, expressed in 1973 dollar values. A distinction is drawn between government work and work financed by the industry by other means. The data were obtained from "National Science Foundation 73-303."

The way in which development in the field of satellite communications leads to continuously increasing savings is demonstrated in Fig. 3, where the costs per telephone channel per year since 1965 are shown.

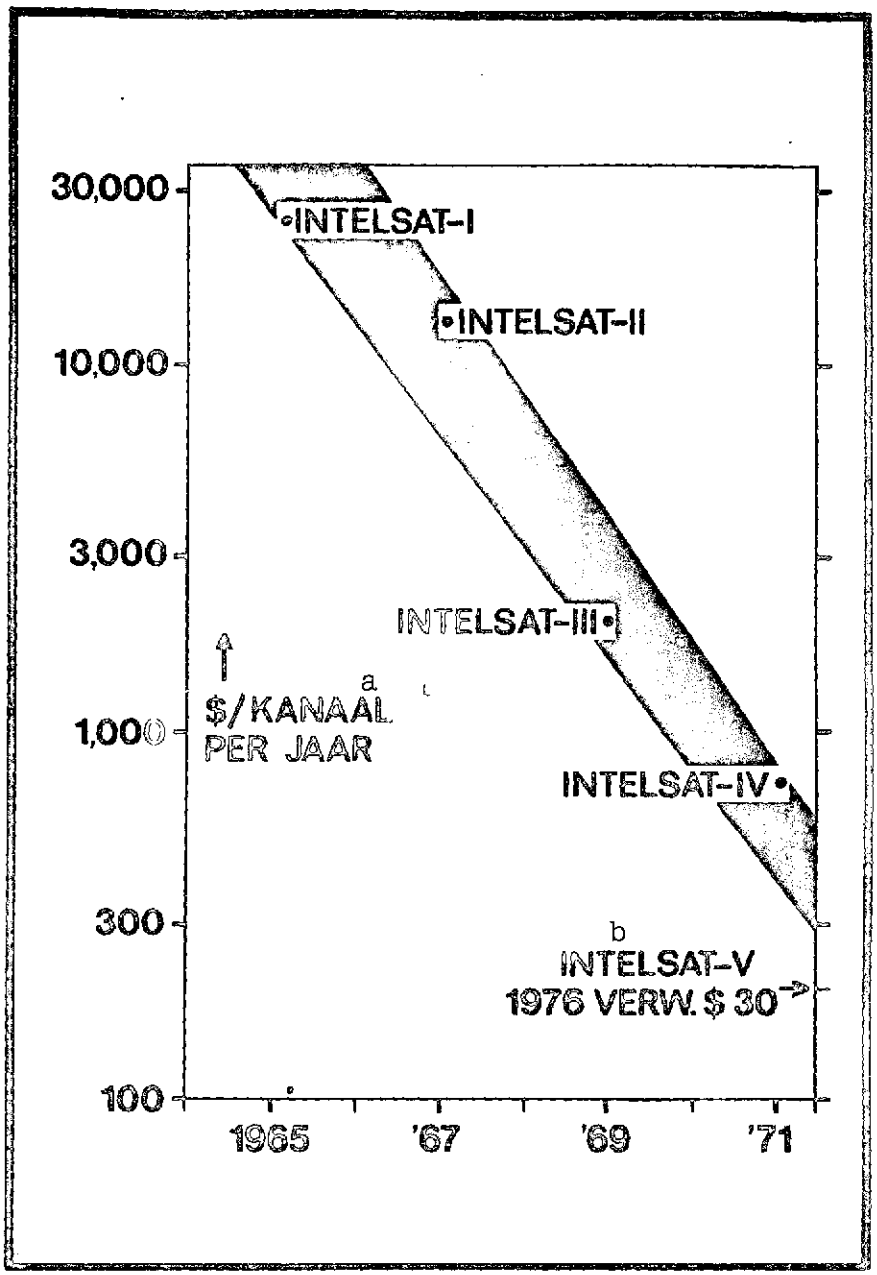

Fig. 3. Cost of communication satellites in dollars per telephone channel per year since 1965 according to J.E. Cole ("International Telecommunications Policy, Planning and Regulation," 1971).

Key: a. dollars/channel per year
b. Intelsat-V, to be expected in 1976: $30

Research and Development, Industry and Society

A number of empirical laws are operative for research and development in industry:

-- For every branch of industry there is a fixed ratio between the efforts for research and development and the volume of business. Deviations from this ratio, both upward and downward, are risky. An industry which lags behind in either quantity or quality will experience difficulties.

-- Research and development are sources of technological improvements, by which better products can be manufactured, the same products manufactured at a lower cost, or entirely new products created.

-- As a result of the fact that within a certain branch of industry various industries perform research and development in the same field, competition will result. This will lead to better and relatively less expensive products.

-- The advantage of research and development for a successful industry is the continuity of employment and also the continuity of returns on the investment for the means of production. The advantages for society are continuously better wages, more favorable employment conditions, and relatively inexpensive products. The greatest advantage of technological advance is clearly for the consumer, not for the employee of the industry or for the stockholder.

-- Industries which are not oriented toward research and development can also profit greatly from the results of technological advances by the availability of more advanced means of production.

These laws are illustrated with the aid of several examples.

Fig. 4 shows a comparison between the development of the /64
cost of wages and raw material on the one hand and, on the other, the development of products of industries oriented towards research and development, such as the aerospace and electronics industry. In spite of inflation, the price of the latter products generally decreases. The products of industries which are not oriented towards research and development, however, generally increase in price, because they usually follow the development of hourly wages and prices of raw materials. Computers, e.g. with a constant price, achieve a performance improvement by a factor of two every 3 years. Many improvements in quality and comfort, such as longevity, reduction in flying time, more safety, etc., are not suitably represented in a simple graph.

Further Analysis of Industrial Research and Development

Three categories are distinguished in industrial research and development:

-- work for which the risks and economic benefits can be calculated;

-- work for which the benefits and the time period in which these benefits become effective, the extent of which is great, are difficult to predict;

Typical examples of the latter are nuclear reactors, commercial satellites, systems for environmental control, and new systems for enery production.

-- work for the government, such as defense.

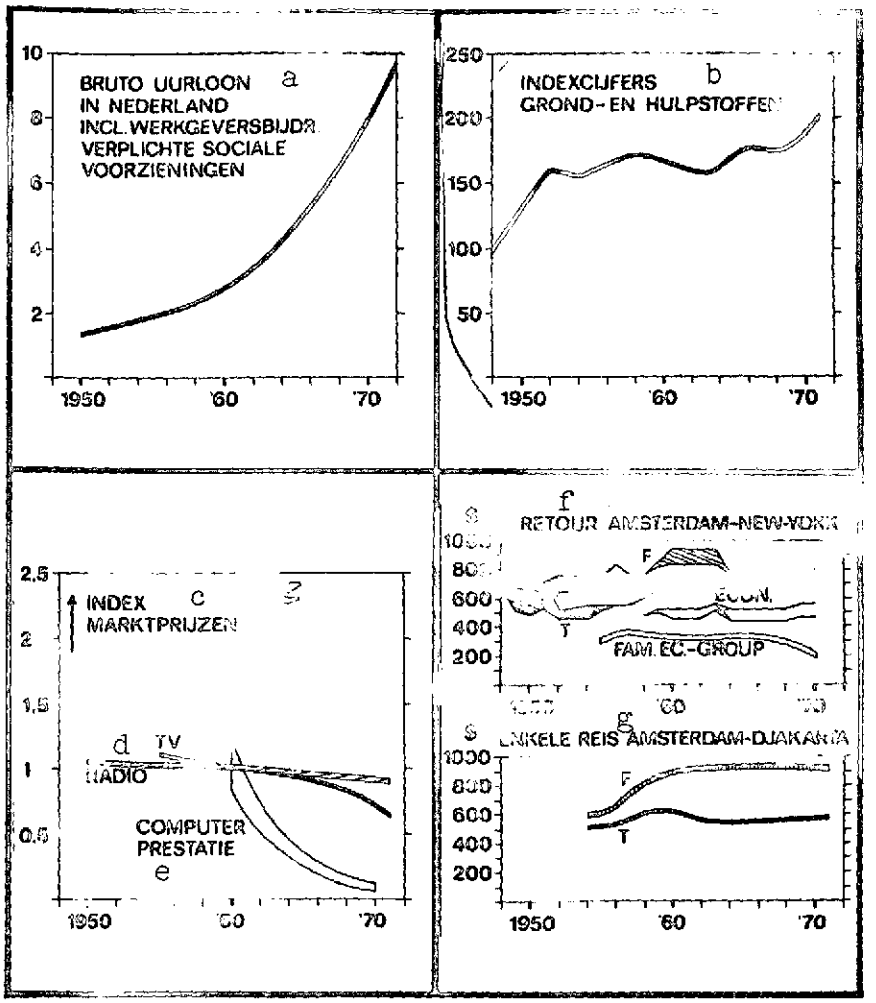

Fig. 4. Comparison between development of costs of wages and raw material and the products of research and development-oriented industries, such as the aerospace and electronics industry. Data regarding gross hourly wages and raw materials were obtained from the C.B.S. (Central Statistics Office).

Key:
a. Gross hourly wages in the Netherlands, including employers' contribution to welfare facilities
b. Index figures for raw material and semifinished products
c. Index market prices
d. Televion, radio
e. Computer performance
f. Return, Amsterdam-New York
g. Single journey, Amsterdam-Djakarta

It is clear that the boundaries between these three categories are not always well defined and that interactions take place between these areas. Work in the first category is usually financed by the industry itself. A government agency is the contractor, and often the owner and operator too, of the industries in the second and third categories.

Basic research, i.e. at universities, may be mentioned as a distinct category. The manner and timing of production of visible results is usually unpredictable. It is also difficult to predict which industries will profit from this research. However, the most important developments emanate from these activities. Basic research is a contribution to expanding the knowledge of mankind.

Research and development supported by an industry itself generally arise from existing activities and a number of promising internal initiatives. The scope is limited by the financial possibilities, which in turn are dictated by economic circumstances. In large countries, such as, e.g., the USA, France and the Soviet Union, the governments assign advanced projects, such as summarized in the second and third categories, to the industries. About half of the electronics research and development in the USA is carried out under government contract, and three-fourths of the research and development in the aerospace industry is financed by the government.

Interconnections between the activities of these three categories are substantial, since similar techniques and technologies are being used. Consequently, the results obtained in the second and third categories are of great significance for activites based on work in the first category. Typical examples for the electronics industry, where the government was the first contractor, are computers and integrated circuits. For certain

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reasons, the United States government needed advanced computers and had them developed by the industry. As a result of these government contracts, the American industry acquired a substantial lead over European industries.

The curve which shows the growth of the gross national product as a result of technological progress indicates how extensive the damage would have been if the European industry had been forced to abandon computer activities. Nevertheless, a substantial and expensive effort is still required to catch up with developments in the USA. In the meantime, the American economy profits from the products of its computer industry and thereby obtains considerable savings. Moreover, an export market has been established. The money that Americans have invested in developmental activities for computers alone is being returned with substantial profits in taxes alone.

Integrated circuits also illustrate a situation in which the American industry acquired a lead due to government initiative. At an early stage, it was clear that the electronics industry would be able to manufacture integrated circuits. However, the economic possibilities could not be predicted at that time. There were very attractive government applications for the circuits, and, as a result of government contracts, this industry also gained a considerable lead. When, after a delay of several years, the European industry eventually began to manufacture these circuits, there were serious difficulties as a result of decreasing prices, as is evident from Fig. 5. In the large European countries, the governments have now recognized the significance for the domestic economy of an advanced national industry by issuing special contracts to the industry for computers and integrated circuits. The production of integrated circuits appears to be remunerative and contributes to the economy of the Netherlands as

well, on the one hand, by their multiple applications in electronic circuits and, on the other, by domestic production of these circuits.

The ANS Project

The ANS project is the first major research and development project undertaken by the Dutch aerospace and electronics industry with government support. The initial investigations began in 1965 at the invitation of E.A. Plate, and the results were presented to the then Minister of Economic Affairs, Dr. J. den Uyl, in July 1966 by Drs. Th.P. Tromp and J.H. Greidanus on behalf of the Dutch aerospace and electronics industries. It had become clear in 1965 that space techniques and technology are closely related to the disciplines of the aerospace and electronics industry. It is well known that many of the refinements to and advances in existing techniques are being developed for space applications.

The responsibility for continuity of the industries necessitated a follow-up of these developments. Space flight, with respect to the use of satellites, as well as launches, is entirely a government matter. A contract from the government is therefore a "condition sine qua non" for work in space technology. /68

Two years after the proposal was submitted, the contract for the ANS project began to crystallize through government contributions for a more detailed study.

On the basis of the above observations, we may draw a number of inferences with respect to the significance of the ANS program for the participating industries:

-- As compared to a world-wide expenditure of about 25 billion dollars per year for research and development in the

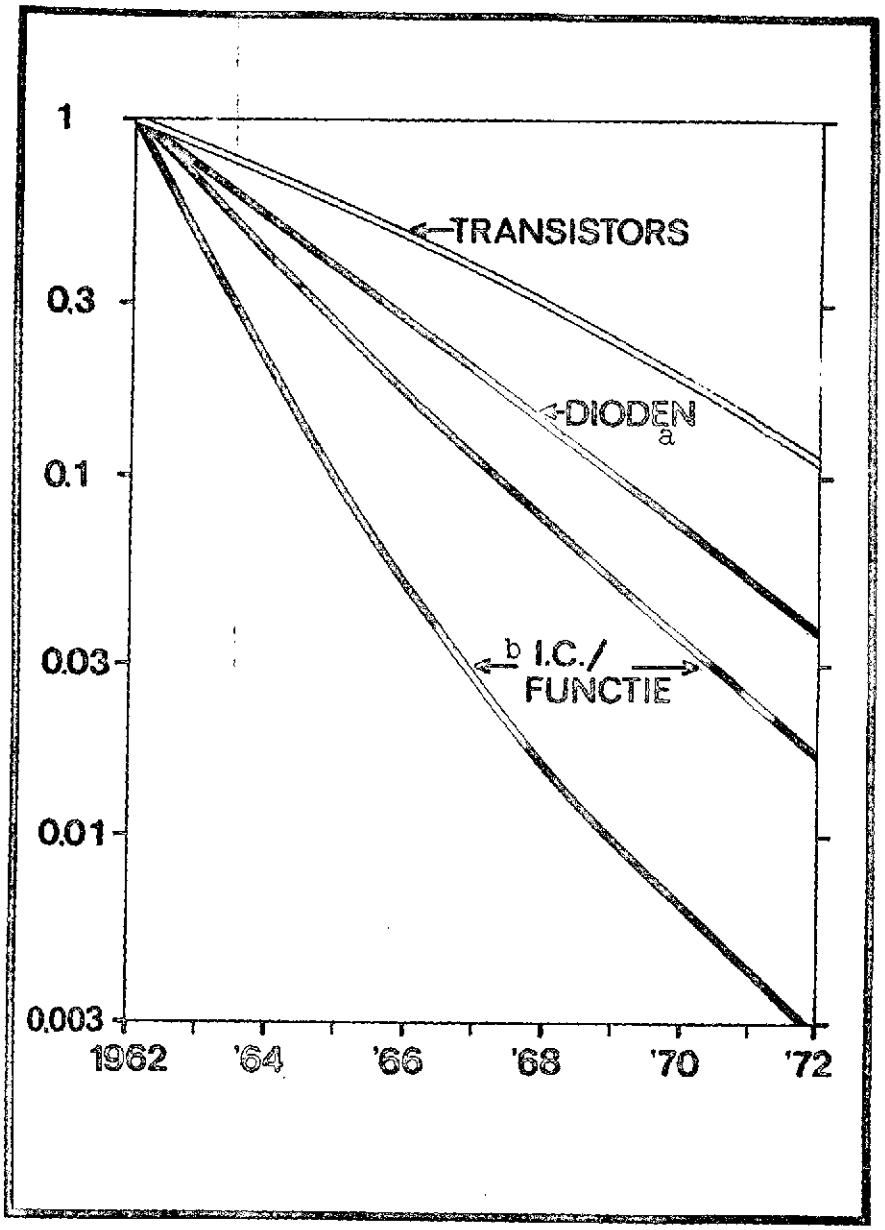


Fig. 5. Course of the price curve of diodes, transistors and integrated circuits during the last 10 years. Two values are indicated for the price of integrated circuits per function. The upper values are taken from W.C. Hittinger, Sc. Am. 229(2), 48 (Aug. 1973). The lower values relate to data compiled by the author.

Key: a. Diodes
b. I.C./function

aerospace and electronics industry, a program involving 3 to 4 million dollars annually will not produce spectacular results.

-- Proportionally, however, the results are substantial, because this is this first coherent program in the Netherlands and also because, since its conception, the industries were involved with drafting the project, its research and development and its realization.

-- By utilizing information offered by NASA and by expert advisers in the USA, the industries had an opportunity to assimilate the knowledge gained in the United States at considerable expense.

-- This knowledge pertains particularly to extremely reliable systems, composed of subsystems, which themselves are made with carefully manufactured components. Many of the subsystems developed in the process may be utilized for other satellite programs.

-- The experience gained in such areas as project definition and project realization in the advanced forms developed for space flight is generally of great value. When the original solutions cannot be realized and new ones are called for, high demands are made on inventiveness and adaptability.

-- The project is a valuable exercise in cooperation between a number of industries, astronomers of various universities and the Dutch government.

This cooperation is important for the government, the industries and the Dutch scientific community, since it will be even more necessary in the future.

-- The ANS program is an intensive exercise in the production of miniaturized, very reliable apparatus with minimal energy consumption. This is very valuable in a time when the limits of our resources and the consequence of environmental pollution have been recognized.

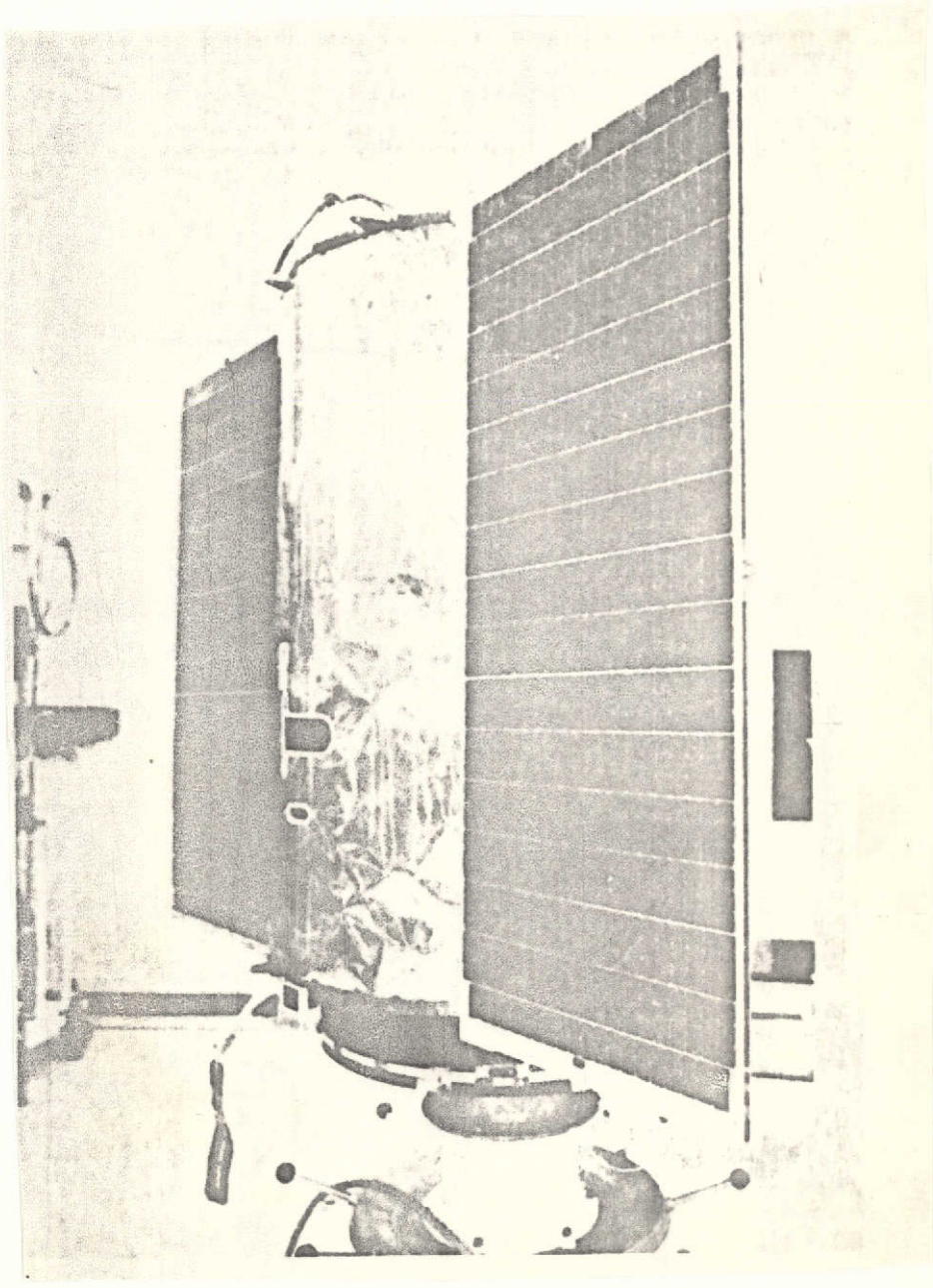
This also illustrates once again that the interests of society and industry run in parallel.

-- As a result of the ANS program, Dutch industry is now /69
able to collaborate on the development of commercial satellites. This is neither the time nor the place to elaborate on this fact. I prefer to limit myself to a reminder that the results have greatly surpassed the expectations in the field of telecommunications satellites.

This presentation has illustrated the fact that the interests of society and industry run in parallel in the field of research and development. This is particularly true in the field of space flight, where there can be no results without government support. The ANS program in the Netherlands demonstrates a framework under which the government, industry and science can cooperate. It appears that the Dutch government realizes that personal well-being and an increase in the standard of living are based on the result of research and development and that government support of the industry is for the good of society. This form of cooperation is necessary to solve today's problems, such as environmental hygiene, transport problems, energy problems, etc.

The Dutch Institute for Aircraft Development and Space Travel (NIVR) should be mentioned here as an example of a focus where the various disciplines are being brought together efficiently.

Maintaining the advances made through the ANS program implies the continuation of the national space flight program. The difficulties encountered in this continuation may well cause some problems, but these may be viewed as initial problems to be expected with a new form of cooperation. This cooperation is effective enough to overcome these problems.



The Dutch astronomical satellite.